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LOW MOLECULAR ORGANIC ACIDS IN SOD-PODSOL FOREST SOILS

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16. Abstract
Fumaric, malonic, citric, succinic, glucuronic, oxalic, and tartaric acids were found in sod-podzolic soil up to the depth of 100 cm by means of thin-layer and paper chromatog. Their partition in the soil profile was the same under spruce or oak forest. The max. quantity of these acids was found in top horizons (0-2; 2-4 cm). The abs. amt. of org. acids was higher under spruce forest than under oak.

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LOW MOLECULAR ORGANIC ACIDS IN SOD PODSOL FOREST SOILS

R. A. Gubanova*

Earlier [1 - 3], the mobilizing and complexing effect of aqueous extractions of woodland floors on hydrates of iron oxide and the role of this effect in the process of hydrate migration were examined. Different authors have succeeded in identifying certain compounds in the aqueous extractions of woodland leaf beds and soils, and have shown that the composition of the water soluble organic substance includes low molecular aliphatic and aromatic acids. /264**

Kaurichev et al. [4] determined the total amount of low molecular organic acids in woodland flowers and in the lysimetric waters of podsol and sod-podsol soils of the mid and southern taiga and the subzones of typical chernozems, solonets***, and solod****.

Vaytkhid [5] investigated the carbonate loamy composition soil under grass, the sandy composition in a bracken fern pine forest, clay composition with an admixture of fine grain sand in a beech

*Presented by Academician of the AN BSSR P. P. Rogobym.

**Numbers in the margin indicate pagination in original foreign text.

***Translator's note: A strongly alkaline dark soil.

****Translator's note: A degraded solonet .

forest and heavy clay soil under currant growth. The author measured the content of p-oxibenzoic, vanylinic, p-coumaric, and ferulic acids.

In studying the soils of flooded rice fields, Takiyama [6] found the following acids in them (in order of decreasing amount): acetic, butylic, formic, oxalic, fumaric, propionic, valerianic, succinic, lactic, and also aromatic acids — benzoic, cinnamic, and salicylic.

Muir [7] and a group of authors found the quantitative content of shikimic malonic, citric, quininic, and phosphoric acids in pine resin. Jacquin and Bruckert [8] measured the mineral and organic (aliphatic and phenol) acids in filtrates obtained under leaching conditions as close to natural ones as possible. The aqueous extract from the forest floor and dark carbonate soil from an oak forest and the acid podsol soil and humus formed by the pine needle fall contained succinic, citric, oxalic, malic, lactic, glucuronic vanillic, p-oxibenzoic, phosphoric, and sulfuric acids.

This sutdy presents the results of our investigations in which the low molecular organic acids present in the water-soluble organic substance in sod-podsol soils in a spruce and pine forest were measured (Vitebskaya and Minsk oblast'). The regions for the investigations were selected in soils that had developed in light clays overlying moraine, and in soils in which the podsol-forming process was most clearly pronounced. The goal of the study was to determine the quantitative content of low molecular organic acids in a sod-podsol soil profile. Up to now, it has not been clear whether they merely accumulate on the forest floor and serve only as a substrate for the development of microorganisms, or whether they are mobile in profile /267
and thus participate in processes in soil formation. Soil samples were chosen according to their genetic strata, in July, 1967, and 1968, and were analyzed for organic acid content by the methods of silica gel column chromatography and paper chromatography [9].

DI- AND TRICARBONIC ACIDS IN THE WATER-SOLUBLE ORGANIC SUBSTANCE OF SOILS* **

Soil	Genetic strata	Sample depth, cm	Sample moisture, %	Aqueous extraction pH	Acid content, mg/l aqueous extraction	Acid content γ/1g absolute dry substance	Measurable acids
Sod-podsol developing on a heavy moraine sandy loam in a spruce forest. Kislichno-chernich spruce, 1967	A_0	0—2	16,0	5,70	—	—	
	A_1'	2—4	24,7	4,82	18,3	457,5	Oxalic, citric, fumaric, succinic, glucuronic, tartaric, malic
	A_1	7—17	4,4	4,25	4,6	11,5	Oxalic, citric, fumaric, succinic, tartaric, malic
	A_2	17—40	3,2	4,65	1,0	2,5	Oxalic, citric
	B_1	40—100	11,5	5,00	2,2	5,5	Oxalic, traces of citric, succinic
Sod-podsol developing on a heavy moraine sandy loam in a mixed deciduous forest (oak, birch). Orlyak oak, 1967.	A_0	0—2	18,3	5,85	17,7	442,5	Oxalic, citric, fumaric, succinic, lactic, glucuronic, malonic, malic
	A_1'	2—5	9,9	5,62	7,4	185,0	Oxalic, citric, fumaric, succinic, lactic, glucuronic, malonic, malic
	A_1	5—23	3,4	4,70	14,3	35,7	Oxalic, citric, fumaric, succinic, lactic, malonic, malic
	A_2	23—39	3,7	5,30	9,2	23,7	Oxalic, citric, succinic
	B_1	50—100	8,8	5,65	1,5	3,6	Oxalic, traces of citric, succinic

(Table continued on following page)

(Table continued)

Soil	Genetic strata	Sample depth, cm	Sample moisture, %	Aqueous extraction pH	Acid content, mg/l aqueous extraction	Acid content, γ/1g absolute dry substance	Measurable acids
Sod-podsol developing on a light moraine clay in a spruce forest. Mossy spruce, 1968	A_0	0—2	33,6	5,40	30,5	760,0	Citric, oxalic, malonic, tartaric, malic, succinic, fumaric, glucuronic
	A_1'	2—4	25,6	4,85	62,4	1500,0	Oxalic, tartaric, citric, malic, succinic, fumaric, glucuronic, malonic
	B_1	57—81	13,7	5,45	14,5	36,2	Oxalic, traces of citric, malonic, succinic
Sod-podsol developing on a light moraine clay in an oak forest. Chernichno-orlyakov oak, 1968	A_0	0—2	14,5	5,20	585,8	14600,0	Oxalic, tartaric, citric, malic, malonic, succinic, fumaric, glucuronic
	A_1'	2—4	33,2	4,98	39,6	990,0	Oxalic, tartaric, malic, citric, malonic, lactic, succinic, fumaric, glucuronic
	A_1	3—7	17,8	4,86	27,4	68,5	Oxalic, tartaric, malic, citric, malonic, lactic, succinic, fumaric
	A_2	11—27	6,7	5,40	9,2	23,0	Oxalic, succinic, citric, fumaric, malonic
	B_1	66—98	20,9	5,54	14,6	36,5	Oxalic, traces of citric, succinic, malonic

(Table concluded on following page)

(Table concluded)

Soil	Genetic strata	Sample depth, cm	Sample moisture, %	Aqueous extraction pH	Acid content, mg/l aqueous extraction	Acid content, γ/1g absolute dry substance	Measurable acids
Lowland peat bushy country dry. Peat-gley soil overlying light sandy loam, 1967	A_{T_1}	2—10	63,4	6,00	13,6	390,0	Oxalic, citric, tartaric, lactic, succinic, fumaric, malonic
	A_{T_2}	70—80	79,3	6,40	16,1	402,0	Oxalic, citric, tartaric, lactic, succinic, fumaric, malonic
	B_1	80—100	15,5	7,05	0,95	2,3	Oxalic

*Calculation made for oxalic acid

**Translator's note: Commas in numbers represent decimal points

A comparison of the results of measurements (table) showed that in the decomposing part of the spruce forest floor (stratum A_1' 2 - 4 cm), more organic acids form that in the same stratum of an oak forest floor, although the oak leaf residue bears a larger amount of the measured acids than the spruce needle residue. The difference in content and mobility of the investigated acids found by us in the forest floors can be explained by the different tendencies of the microbiological processes in them.

The character of distribution of the measured compounds is the same for soils under both types of trees with respect to the genetic strata. In the forest bed represented by two strata (A_0 — leaf fall, and A_1' — a humus bed consisting of decayed and partly decayed leaf falls of past years), in comparison with the other strata of the soil profile, there is a maximum amount of low molecular organic acids. The presence of the latter in the decaying stratum (A_1), the podsol stratum (A_2), and the illuvial (B_1) stratum indicates the constancy of their entry into the composition of the water soluble organic substance during washout by melted snow and rain water.

The distribution of acids varies significantly with respect to soil strata. If, in the forest beds and decaying strata, one finds glucuronic, oxalic, citric, tartaric, succinic, fumaric, and malonic acids, then in strata A_2 and B_1, we find only oxalic, citric, succinic, malonic and fumaric acids, and in certain samples — only oxalic and citric acids. Apparently, these acids cover a pathway of 0 - 100 cm not only in the greatest amount, but also as the ones more resistant to microbiological decomposition and other transformations. It has already been noted in the literature [10], for example, that the uronic acids are easily broken down by humification and enter the composition of the humic acids as structural units.

Differences in the content of acids in soils by years can be explained by the absence of rain in the spring and summer period of

1967, and, to a significant degree, by the different character of the forest and forest floor.

In the aqueous extractions of the peat soil of the lowland type, the same acids are present as in the forest floors.

Hence, identification and quantitative determination of the acid product making up the water soluble organic substance in all the genetic strata of sod-podsol soils that develop on moraine clays and sandy loams on a forest floor show the presence of a significant amount of low molecular organic acids. In the form of aqueous solution in concentrations of about 0.001 n., the latter reached the alluvial stratum which indicates their mobility in the soil profile, and, consequently, their participation in soil processes and in the formation of soils.

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